

Chapter 5: WRIA 8 Conservation Strategy

How are We Using Science to Guide Effective Actions?

The purpose of this section is to document the scientific rationale for the conservation actions that will be described in Chapter 6. The Conservation Strategy is a series of hypotheses about how the rehabilitation of WRIA 8's three Chinook populations can be achieved through landscape-level and in-stream conservation actions. A summary of the Conservation Strategy is included at the end of this section. As described in Chapter 4, these hypotheses were developed using three analytical tools help the WRIA 8 Technical Committee (W8TC) answer fundamental questions about Chinook populations, watershed conditions, and in-stream habitat conditions:

***Viable Salmonid Population (VSP) Framework:** What is the status of Chinook populations in WRIA 8, and what are the sources of risk to population viability?*

Based on guidance from NOAA Fisheries Puget Sound Technical Review Team, the W8TC assessed the status of each independent Chinook population by looking at four population parameters: productivity, spatial distribution, diversity, and abundance. For each population the relative risk for each population parameter was also assessed to help target conservation actions. This assessment focused on parameters other than abundance, as abundance is influenced by factors other than habitat such as hatchery interactions, harvest, and ocean conditions. The Technical Committee hypothesizes that conservation actions designed to benefit diversity, spatial distribution, and productivity will support increases in abundance. If impacts to population abundance from hatchery influences, harvest, and unfavorable ocean conditions become reduced, local conservation actions will have a proportionately greater effect on population abundance.

***Watershed Evaluation:** Within each of the three populations, how should conservation efforts be designed to reflect fish use and the relative watershed conditions in each sub-area?*

The watershed evaluation tool was developed to stratify sub-areas used by each population based on how the sub-area is used by Chinook and the relative level of watershed function in the sub-area. By combining this information sub-areas were divided into three tiers, along with areas used for migration and rearing. Actions in areas of high watershed function should focus on protecting habitat attributes and habitat-forming processes; actions in areas of moderate or low watershed function will require restoration of key habitat attributes and habitat-forming processes. Tier 3 areas with episodic Chinook use were not included in the WRIA 8 Ecosystem Strategy at this time. The EDT diagnosis of habitat limiting factors and restoration priorities is available for many of these streams, and the tiering of sub-areas will be re-evaluated by the W8TC to include use by coho and other salmonids.

***Ecosystem Diagnosis and Treatment (EDT):** Within each sub-area, what habitat conditions should be protected or restored to rehabilitate the population?*

The EDT Model is a riverine habitat model that was customized by the W8TC and regional experts to include the nearshore, estuary, Ship Canal and Locks, the Sammamish River, and Lakes Washington, Sammamish, and Union. The EDT model compares the survival of Chinook under current and template habitat conditions to 'diagnose' habitat limiting factors and provide a relative sense of the protection or restoration potential of different stream reaches and sub-areas. At the direction of the Steering Committee, the W8TC has not undertaken the 'treatment' step to compare the relative effectiveness of proposed conservation actions. The EDT habitat model has

been used extensively throughout the Pacific Northwest to support a variety of different salmon conservation efforts, and it is important to remember that the strength of the EDT model is in its ability to make relative comparisons of habitat conditions and salmon performance. The model is not a salmon population model and is therefore not intended to predict overall salmon population abundance, or the numbers of fish that will benefit from a specific conservation action.

Additional information about the application of these analytical methods is available in Appendix ____.

Viable Salmonid Population Guidance for WRIA 8

As noted in Chapter 4, the Puget Sound Technical Review Team (TRT) has identified three independent populations of Chinook in WRIA 8: Cedar River, North Lake Washington (NLW), and Issaquah Creek. Each of the three independent Puget Sound populations will be included in the ESU-level recovery effort, and the task for the WRIA 8 conservation plan is to ensure the availability of habitat of sufficient quality to minimize the risk of extinction from a variety of natural changes in the environment and population genetics.

The risk of extinction posed to all three populations is extreme and must be reduced through actions that create habitat conditions that support viability of the populations. This chapter will therefore provide conservation hypotheses for all three populations. However, the interactions between these populations and the need for additional information about population genetics leads to the following conclusions that should guide conservation actions across the WRIA:

1. The Cedar and NLW populations are both in crisis with an extreme risk of extinction. However, there is some uncertainty that the NLW and Issaquah populations are independent of one another, while there is higher certainty that the Cedar population is independent. The Technical Committee therefore hypothesizes that a higher priority should be placed on risk reduction for the Cedar population.
2. (NOTE: this conclusion is currently being re-evaluated by the W8TC at their 2/4/04 meeting). Currently, environmental conditions in the Sammamish River (specifically high temperatures) limit adult salmonid migration through this corridor. Under these conditions, actions to increase the abundance and productivity of the Issaquah population could unintentionally increase straying into the NLW tributaries, resulting in a dilution of the genetics of both populations. Therefore, the Technical Committee hypothesizes that restoration actions designed to increase productivity and abundance in the Issaquah population should wait until environmental conditions in the Sammamish River are more favorable to Chinook so that the risk of mixing the populations is minimized. Protection of existing high-quality habitat in the Issaquah system should continue while conditions in the Sammamish River are improved.

The following section describes conservation strategies for each of the three independent populations in WRIA 8, based on the Technical Committee's analysis of VSP status, the watershed evaluation, and the EDT habitat model.

Conservation Strategy for Cedar River Chinook

VSP Status and Relative Risk for Cedar River Chinook

For the WRIA 8 Cedar Chinook population, the assessment of the VSP population parameters can be summarized as follows:

Productivity: Reduced by habitat degradation.

Diversity: In-stream juvenile rearing life history trajectory reduced by habitat loss.

Spatial Structure: Historically, it is likely that Chinook were distributed predominately along the mainstem Cedar, with tributaries playing a relatively minor role in terms of overall abundance. The spatial distribution of the population is largely longitudinal along the length of the mainstem Cedar River.

Abundance: As shown in Chapter 4, the population abundance is in steep decline, driven primarily by reduction in habitat productivity and the loss of life history diversity. Hatchery strays are assumed to contribute to the current observed abundance.

At this time none of the four VSP attributes is sufficient to support viability of the population. Rehabilitation of all population attributes will be necessary to restore the population. The relative risk posed to each of the four population attributes is:

- Productivity: High
- Diversity: Moderate
- Spatial Structure: Low
- Abundance: High (the W8TC assumes that increases in abundance result from rehabilitating the other three population attributes).

The W8TC suggests the following hypotheses based on this assessment of population attributes and relative risk:

- All population attributes require restoration if the Cedar Chinook population is to be viable.
- Of the four population attributes, the greatest risk comes from reduction in habitat productivity and the potential loss of the in-stream juvenile rearing life history strategy.

Watershed Evaluation Framework for the Cedar River

Following the assessment of Chinook salmon population attributes, the Technical Committee stratified sub-areas within each of the three WRIA 8 Chinook populations based on the degree of fish use and the level of watershed function. Using Chinook salmon demographic information to assess the relative abundance within sub-areas and the frequency that sub-areas are used by Chinook, the Cedar sub-areas can be organized as follows:

- Core areas of high Chinook abundance and frequent use – Cedar Middle (Reaches 12-18), Cedar Lower (Reaches 1-11)
- Satellite areas of moderate Chinook abundance and moderately frequent use – Upper Cedar (Reaches 19-28), Rock Creek (Lower), Taylor / Downs Creek, Walsh Lake Diversion.
- Migratory areas – Lakes Washington and Union, Ship Canal, Nearshore and Estuary.

- Episodic areas with infrequent Chinook use – Peterson, Madsen, Molasses.

The relative watershed function of these sub-areas can then be assessed by rating factors that sustain function and factors that limit function:

- Factors sustaining watershed function: wetland area, forest cover, riparian cover, gradient less than 2%.
- Factors limiting watershed function: Impervious surface, flow volume, road crossings, gradient >4%.

Following an assessment of watershed function factors listed above, the sub-areas that contribute to the Cedar Chinook population can be organized as follows:

- High Function – Cedar Main “Rural” (Reaches 12-18), Rock Creek, Upper Cedar, Walsh Lake Diversion, Taylor / Downs Creek, Peterson Creek.
- Moderate Function – Cedar Main “Urban” (Reaches 1-11).
- Low Function – Madsen Creek, Molasses Creek, Lakes Washington and Union, Ship Canal, Nearshore and Estuary.

By combining the fish use and watershed function ratings, the W8TC has stratified the sub-areas that contribute to the Cedar population as follows:

- Tier 1 - Cedar Main “Rural” (Reaches 12-18), Cedar Main “Urban” (Reaches 1-11), Migratory Areas (Lakes Washington and Union, Ship Canal, Nearshore and Estuary).
- Tier 2 - Rock Creek, Upper Cedar, Walsh Lake Diversion, Taylor / Downs Creek.
- Tier 3 - Peterson Creek, Madsen Creek, Molasses Creek.

The W8TC suggests the following hypotheses based on the Watershed Evaluation Framework:

- Protection and restoration actions will be necessary in both tier 1 and tier 2 areas to rehabilitate Cedar Chinook productivity, diversity, spatial distribution, and abundance.
- Watershed function can be improved by improving watershed conditions that limit function (i.e. total impervious area and road crossings) and enhancing factors that sustain function (i.e. total forest cover and riparian forest cover).
- Actions in areas of high watershed function should focus on protecting habitat attributes and habitat-forming processes; actions in areas of moderate or low watershed function will require restoration of key habitat attributes and habitat-forming processes.

EDT Habitat Model Results and Recommendations for the Cedar River

The results of the EDT diagnosis for each sub-area, and the protection and restoration hypotheses developed based on the application of VSP, the Watershed Evaluation Framework, and EDT are summarized in the following section. An appendix with a description of the EDT stream reaches is also included at the end of this document.

Habitat Protection and Restoration Hypotheses in the Cedar Chinook Tier 1 Sub-Areas

The Tier 1 sub-areas include Cedar Middle (EDT Reaches 12-18) and Cedar Lower (EDT Reaches 1-11). Each of these sub-areas is a core area for Chinook use. Cedar Middle has a relatively high level of watershed function resulting from a low impervious surface percentage, few road crossings, and a high level of forest cover and riparian forest. The Lower Cedar has a moderate level of watershed function, due primarily to increases in impervious surface and storm flow volumes, along with reductions in forest cover and riparian cover.

Habitat Protection Hypotheses for the Cedar Chinook Tier 1 Sub-Areas

Recommendations for these sub-areas focus on protection of the habitat processes and structures that make these areas a significant source of production for the Cedar Chinook population. Using the EDT habitat model, the Technical Committee hypothesizes that in all three Tier 1 sub-areas the life stages most affected by existing high-quality habitat conditions are egg incubation, fry colonization and pre-spawning migrants. These critical life stages are sustained by protection of the following habitat attributes:

- Water quality (sediments, temperature, metals)
- Flows (sufficient flows during seasonal low flow periods)
- Habitat quantity (pool habitats)
- Habitat attributes that contribute to the creation of pool habitats (riparian function, LWD, channel connectivity).

By comparing the survival of Chinook life stages under existing conditions and fully degraded habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for protection. The protection potential of reaches in the Tier 1 sub-areas is shown in Figure 1. The protection potential identified by EDT results from habitat conditions in the stream reach as well as the habitat-forming processes that create and maintain those habitat conditions. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire sub-area (Table 5-1) as well as individual stream reaches (Table 5-2).

**Table 5-1: Basin-Wide Protection Recommendations for Tier 1 Sub-Areas
(Cedar Middle Reaches 12-18, Cedar Lower Reaches 1-11)**

- Protect water quality to prevent adverse impacts to key life stages from fine sediments, metals (both in sediments and in water), and high temperatures. Adverse impacts from road runoff (especially the Maple Valley Highway SR 169) should be prevented.
 - Forest cover should be protected throughout each of the sub-areas to maintain watershed function and hydrologic integrity (especially maintenance of sufficient baseflows), and protect water quality.
 - Road crossings should be minimized to maintain floodplain connectivity
 - Provide adequate stream flow to allow upstream migration and spawning by establishing in-stream flow levels, enforcing water right compliance, and providing for hydrologic continuity.
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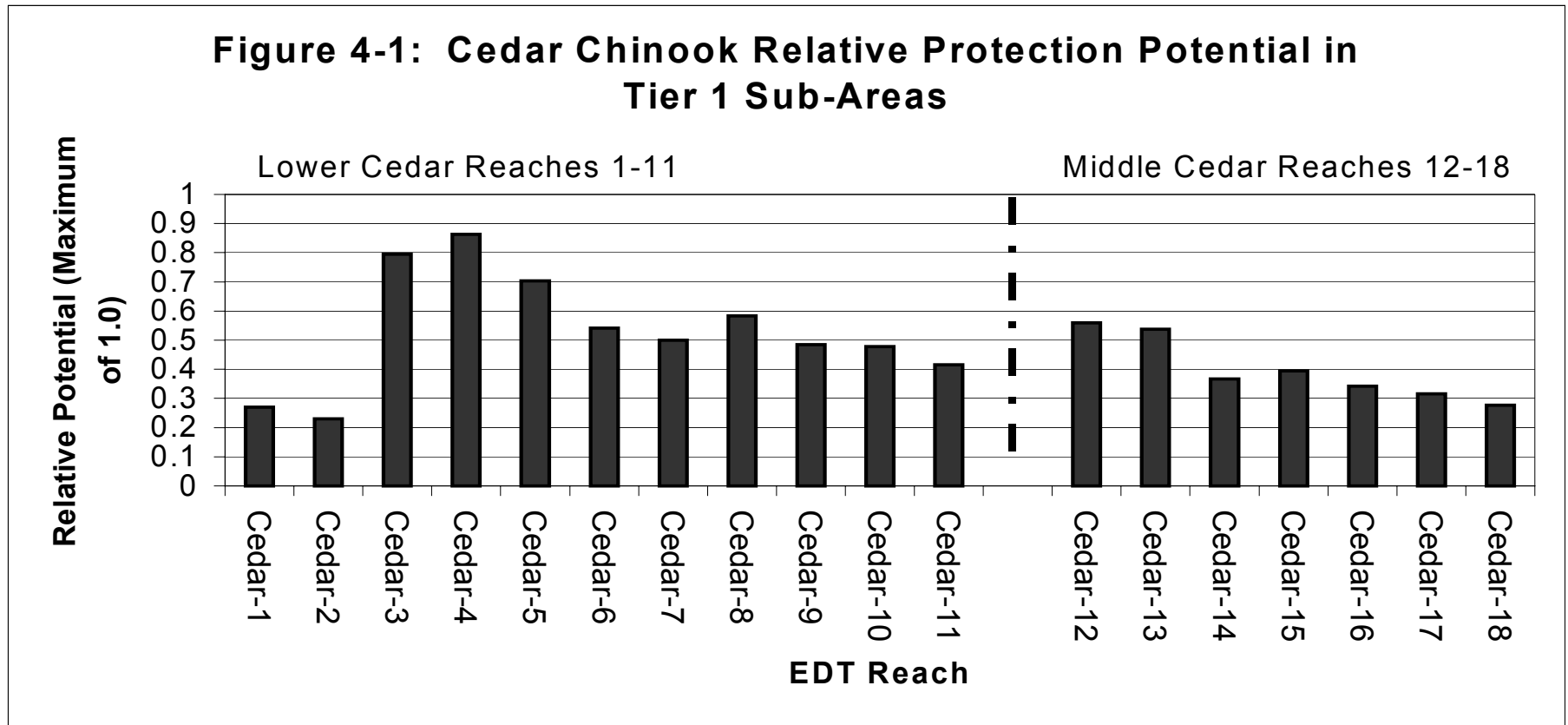
**Table 5-2: Cedar Tier 1 Reach-Level Protection Recommendations
(Middle Cedar and Lower Cedar)**

Reaches are listed in order of Relative Protection Priority

<i>Tier 1 Sub-Area:</i>	<i>Critical Chinook Life Stages for Protection:</i>	<i>EDT Protection Potential: Protect pool habitats, LWD, riparian function, and channel connectivity, in the following reaches:</i>	<i>High-quality pool habitat should be protected in the following reaches:</i>	<i>LWD, Riparian Function, and Channel Connectivity should be protected in the following reaches:</i>
<i>Middle Cedar (Reaches 12-18)</i>	Pre-Spawning Migrant; Fry Colonization	12, 13, 15, 14, 16, 17, 18	13, 15, 16, 14, 17, 18, 12	16, 17, 18, 15, 14, 12, 13
<i>Lower Cedar (1-11)</i>	Pre-Spawning Migrant; Fry Colonization	4, 3, 5, 8, 6, 7, 9, 10, 11, 2, 1	5, 4, 2, 3, 7, 8, 10, 9, 11, 6, 1	4, 8, 7, 3, 5, 6, 11, 10, 9, 1, 2

Reach Protection Priorities:

- In each sub-area, pool habitat and the habitat features that support the creation of pool habitat (LWD, riparian function, and channel connectivity) should be maintained in reaches with high protection potential in order to maintain key Chinook life stages (see Figure 5-1).
- In the Middle Cedar, riparian function, LWD, and channel connectivity should be maintained in reaches with higher use for spawning and egg incubation (Reaches 14-16)
- In the Middle Cedar, riparian function, LWD, and channel connectivity should be maintained in reaches with a relatively lower protection potential (reaches 16-18) to support spawning and egg incubation in downstream reaches 14-16.
- The landslide reach (Reach 4) has the highest protection potential on the Cedar River. Channel connectivity, LWD, pool habitats, and riparian function should be maintained within this reach to support the potential identified by EDT and to serve as a reference site for habitat restoration efforts in other parts of the Cedar River.
- In the Lower Cedar, pool habitats, LWD and channel connectivity in reaches adjacent to Reach 4 should be maintained to support the potential that exists in these reaches.
- In the Lower Cedar, Riparian function, LWD, and channel connectivity should be maintained in reaches with relatively higher use for spawning and egg incubation in the Lower Cedar sub-area (Reaches 7-9).



NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (ie hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each sub-area in the Conservation Strategy.

Based on the three analytical tools described above, the W8TC hypothesizes that conservation actions based on the basin-wide and reach-specific protection recommendations will maintain habitat conditions that are currently favorable to critical Chinook life stages. The Technical Committee hypothesizes that actions based on these recommendations will maintain favorable conditions for these life stages in each of the Tier 1 sub-areas (Cedar Middle and Cedar Lower) and will ultimately support the existing sources of productivity and life history diversity for the Cedar River Chinook population.

Habitat Restoration Hypotheses for the Cedar Chinook Tier 1 Sub-Areas

Although protection of existing high-quality habitat and habitat-forming processes is the primary objective in the Tier 1 sub-areas, restoration of watershed function and in-stream habitat attributes is necessary to the rehabilitation of Cedar Chinook productivity and life history diversity. Based on the EDT habitat model, the Technical Committee hypothesizes that the life stages most affected by degraded habitat conditions in these reaches are fry colonization and pre-spawning migrants. These critical life stages are limited by degradation of the following habitat attributes:

- Habitat quantity (pool habitat area),
- Habitat quality (composed of channel confinement, riparian function, and large woody debris).

By comparing the survival of Chinook life stages under existing conditions and fully restored habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for habitat restoration. The restoration potential of reaches in the Tier 1 sub-areas is shown in Figure 2. The relative restoration potential identified by EDT results from habitat conditions in the stream reach as well as up-stream habitat-forming processes that create and maintain those habitat conditions. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire sub-area as well as individual stream reaches. These recommendations are summarized in Table 5-3. The recommended changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the productivity, spatial distribution, and life history diversity of the North Lake Washington Chinook population.

**Table 5-3: Cedar Chinook Tier 1 Restoration Recommendations
(Cedar Middle and Cedar Lower)**

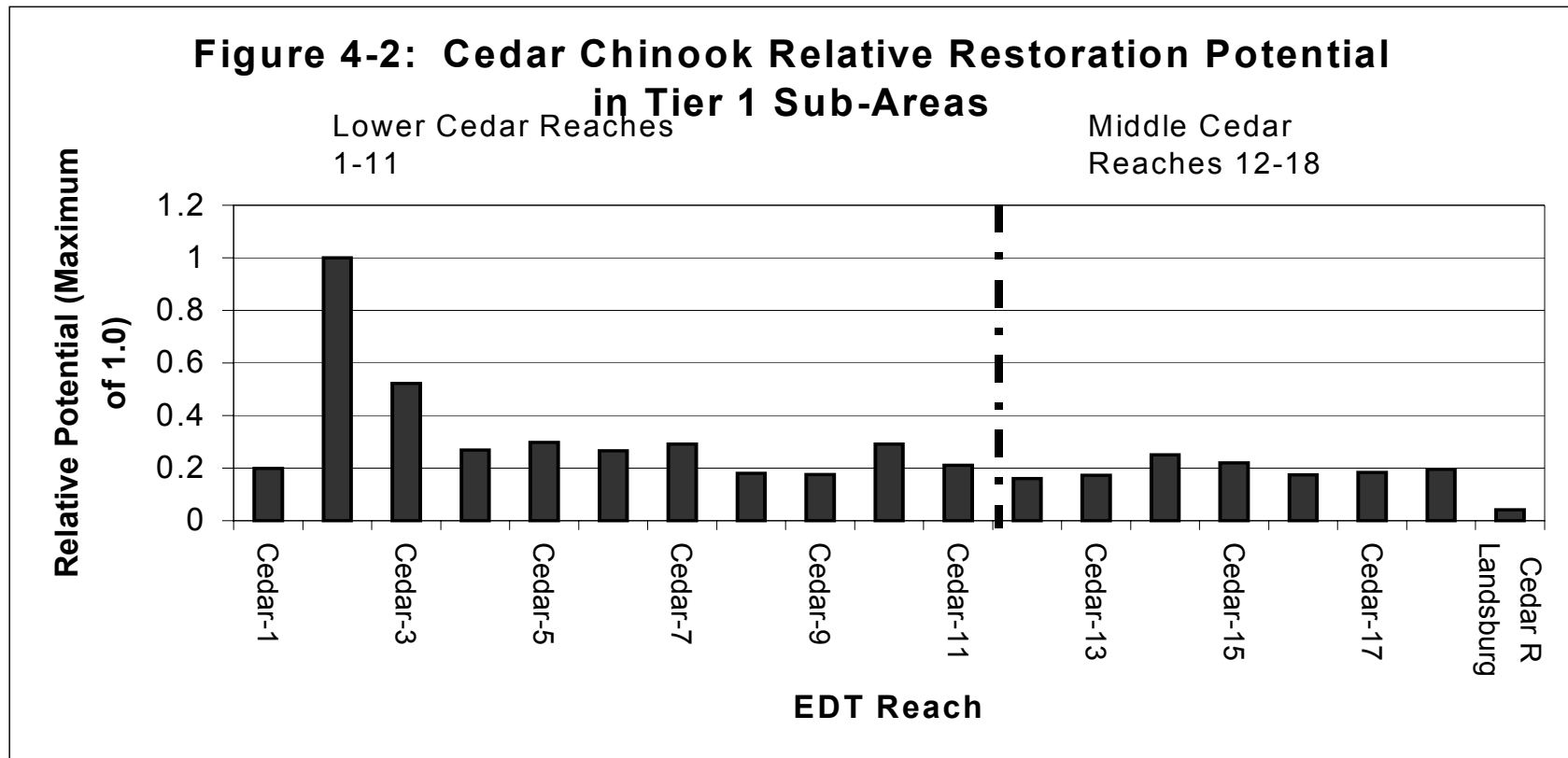
Basin-Wide Recommendations

- Restore riparian vegetation to provide sources of LWD that can contribute to the creation of pool habitat.

Reach-Specific Recommendations

- Channel confinement has reduced floodplain connectivity and reduced the amount of pools and small cobbles. Reach-level restoration actions should focus on setback or removal of dikes and levees, the addition of LWD to create pools, and planting riparian vegetation.
 - In the long-term, potential LWD source areas upstream should be restored.
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These changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the productivity and life history diversity of the Cedar Chinook population.



NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (ie hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each sub-area in the Conservation Strategy.

Restoration of Migratory and Rearing Areas for Cedar River Chinook

While restoration of the Tier 1 sub-areas is critical to rehabilitate the productivity and life history diversity of the Cedar Chinook population, restoration of Lake Washington should also be a high priority for regional restoration efforts. The EDT results provide a relative sense of the restoration potential in Lake Washington versus the Cedar River, with a restoration potential in the Lake approximately equal to the potential that exists in the mainstem of the Cedar below Landsburg Dam.

Based on the EDT habitat modeling effort, juvenile migrants from the Cedar River would benefit from actions that reduce predation by cutthroats and other predators in Lake Washington. Predation on juvenile Chinook appears to be driven primarily by conditions that limit cover for Chinook and increase exposure to predators, such as bank hardening, steep slopes, and a lack of LWD and shoreline vegetation. Restoration actions for Lake Washington are summarized in Table 5-4.

**Table 5-4: Restoration Recommendations for
Cedar River Chinook Migratory and Rearing Areas**

Lake Washington:

- Reduce bank hardening by replacing bulkheads and rip-rap with sandy beaches with gentle slopes designed to maximize littoral areas with a depth of less than 1 meter.
- Reconnect and enhance small creek mouths as juvenile rearing areas. Historically these small creeks had sandy deltas at the creek mouth and were associated with wetland complexes. Restoration efforts should with lake segments adjacent to the Cedar River, along with other high potential reaches along the south shore of Mercer Island and in Union Bay.
- More information is needed about the trajectories of Cedar River juvenile Chinook in Lake Washington.
- Shoreline processes of Lake Washington have been changed by the regulated maximum one foot rise and fall of the lake. Therefore, the removal of bank hardening structures may not be sufficient to create sandy beaches and augmentation of sediment supplies may be necessary.
- The outmigration of juvenile Chinook would benefit from improved shoreline connectivity. The use of mesh dock surfaces and/or community docks would reduce the severity of predation on juvenile Chinook.
- Coho runs in smaller tributaries should be restored as a control mechanism to reduce the cutthroat population.
- Consider increases in fishing limits for cutthroat trout.

Ship Canal and Locks:

- High water temperatures impede juvenile Chinook outmigration during the summer in the Ship Canal. These high temperatures also lead to increased activity by predators (primarily bass). Options to reduce water temperatures in the Ship Canal should be evaluated.
- Additional investigations are needed to determine habitat characteristics that could provide Chinook with refuge from predators in the Ship Canal.
- Riparian vegetation should be restored to provide cover for juvenile migrants.

Estuary and Nearshore: TBD

Habitat Protection and Restoration Hypotheses in the Cedar Chinook Tier 2 Sub-Areas

The Tier 2 sub-areas for the Cedar Chinook population include Lower Rock Creek, the Upper Cedar (above Landsburg)¹, Taylor/Downs Creek, Peterson Creek, and Walsh Lake Diversion. At this time the Technical Committee has prepared recommendations for the Upper Cedar, Lower Rock, and Taylor/Downs Creek. All of these sub-areas are considered to be satellite areas for the Cedar Chinook population. As noted in the VSP analysis of the Cedar Chinook population, the tributaries are believed to have played a relatively small role in the spatial distribution and overall abundance of the population. However, the availability of high-quality habitat in these areas is necessary to reduce the risk of natural disturbances (i.e. landslides) that could impact spawning areas in the mainstem Cedar. In addition, the Upper Cedar sub-area provides increased spatial distribution of Chinook along the mainstem of the Cedar River.

Each of these sub-areas has a relatively high level of watershed function, driven by low impacts from impervious surface and road crossings and relatively high levels of riparian and forest cover. Taylor/Downs Creek has experienced relatively moderate increases in storm volumes, while all three of these sub-areas have relatively moderate or low percentages of wetlands.

Habitat Protection Hypotheses for the Cedar Chinook Tier 2 Sub-Areas

The life stages most affected by existing high-quality habitat conditions are egg incubation, fry colonization and pre-spawning migrants. These critical life stages are sustained by protection of the following habitat attributes:

- Water quality (sediments, temperature, metals)
- Flows sufficient for pre-spawning migration
- Habitat quantity (pool habitats)
- Habitat attributes that contribute to the creation of pool habitats (riparian function, LWD, channel connectivity).

By comparing the survival of Chinook life stages under existing conditions and fully degraded habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for protection. The protection potential of reaches in the Cedar Tier 2 sub-areas is shown in Figure 5-3. The protection potential identified by EDT results from habitat conditions in the stream reach as well as the habitat-forming processes that create and maintain those habitat conditions. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire sub-area as well as individual stream reaches (Table 5-5).

¹ Full passage at Landsburg Dam was assumed as part of the EDT habitat modeling exercise in order to determine the protection and restoration potential in these reaches.

**Table 5-5: Protection Recommendations for Cedar Tier 2 Sub-Areas
(Upper Cedar, Lower Rock Creek, Taylor/Downs Creek)**

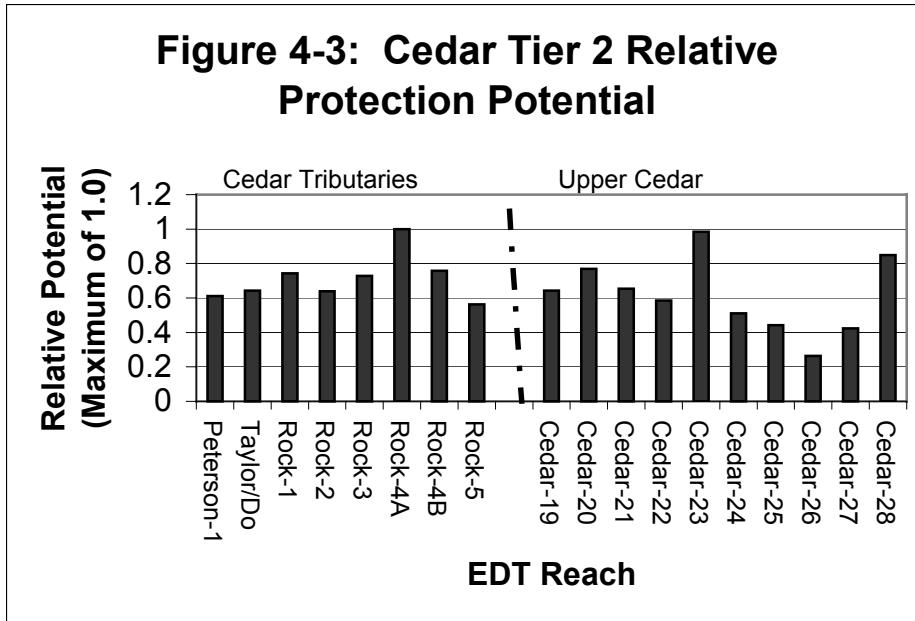
Basin-Wide Protection Hypotheses:

- Protect high watershed function by maintaining forest cover, riparian cover, and minimizing the amount of road crossings and impervious surface.
- Protect water quality to prevent adverse impacts to key life stages from fine sediments, metals (both in sediments and in water), and high temperatures. Adverse water quality impacts from road runoff and other sources of non-point source pollution should be prevented.
- Protect adequate flows during seasonal low flows to maintain the pre-spawning migrant life stage in Rock and Taylor/Downs Creek.
- The Upper Cedar River Watershed is protected by the City of Seattle as a water supply source. No protection recommendations were developed for this sub-area.

Reach-Specific Protection Hypotheses:

- Pool habitat and the habitat features that support the creation of pool habitat (LWD, riparian function, and channel connectivity) should be maintained in reaches with high protection potential in order to maintain key Chinook life stages. In Lower Rock Creek, protection efforts should begin with reaches 1, 3, and 5.
 - Pool habitat, riparian function, LWD, and channel connectivity should be maintained in reaches with a relatively lower protection potential (Lower Rock Reach 5) to support spawning, egg incubation, and pre-spawn migration in downstream reaches 4A and 4B.
 - In Taylor/Downs Creek, pool habitat and the habitat features that support the creation of pool habitat (LWD, riparian function, and channel connectivity) should be maintained in reach 1 in order to maintain key Chinook life stages in this sub-area.
 - In the Upper Cedar, protect LWD in the channel unless it poses a danger to dam operations.
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Protection of these habitat attributes at the reach and basin scale is intended to maintain habitat conditions that are currently favorable to critical Chinook life stages. The Technical Committee hypothesizes that maintaining favorable conditions for these life stages in the Upper Cedar will ultimately support future sources of productivity and life history diversity for the Cedar Chinook population. In Lower Rock and Taylor/Downs Creeks, protection of favorable habitat conditions for Chinook will maintain spatial distribution and reduce the risk of catastrophic environmental disturbances for the population.



Habitat Restoration Hypotheses for the Cedar Chinook Tier 2 Sub-Areas

While restoration of the Tier 1 and migratory areas have a higher relative potential to improve the viability of the Cedar population, restoration in the Tier 2 tributaries is necessary to enhance the productivity of the population and ensure that high-quality habitat is available to the population in the event of natural environmental disturbances in the mainstem of the Cedar. In the tributary systems, the life stages most affected by degraded habitat conditions in these reaches are spawning, egg incubation, pre-spawn holding, and pre-spawn migration. These critical life stages are limited by degradation of the following habitat attributes:

- Habitat quantity (pool habitat types),
- Habitat quality (composed of channel confinement, riparian function, and large woody debris).
- Sediment load (fine sediments, turbidity, and embeddedness).
- Low flows.

By comparing the survival of Chinook life stages under existing conditions and fully restored habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for habitat restoration. The restoration potential of reaches in the Cedar Tier 2 sub-areas is shown in Figure 5-4. The relative restoration potential identified by EDT results from habitat conditions in the stream reach as well as up-stream habitat-forming processes that create and maintain those habitat conditions. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire sub-area as well as individual stream reaches. These recommendations are summarized in Table 5-6. The recommended changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the spatial distribution and productivity of the Cedar Chinook population.

**Table 5-6: Restoration Recommendations for Cedar Tier 2 Sub-Areas
(Lower Rock Creek, Taylor/Downs Creek, Upper Cedar)**

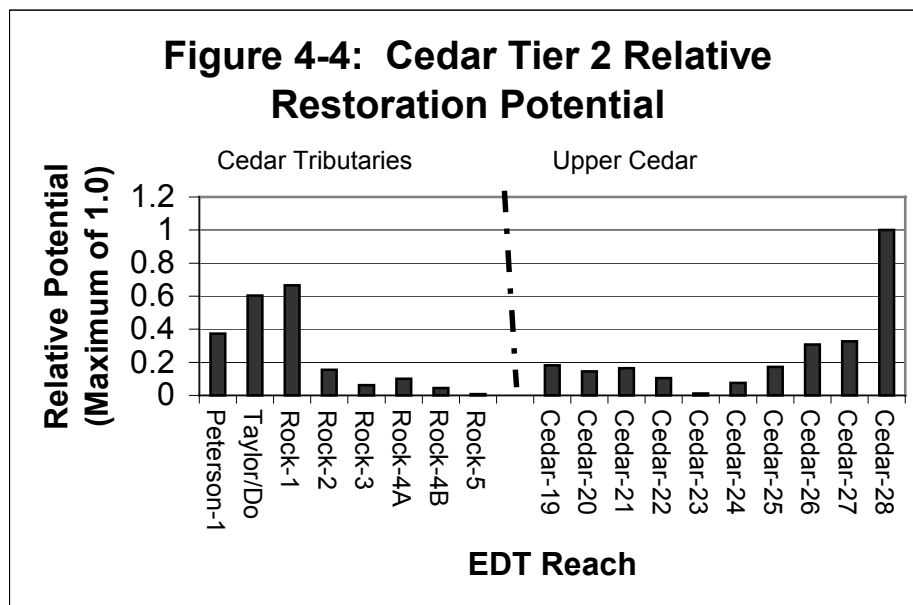
Basin-Wide Hypotheses:

- Re-vegetate riparian corridor with deciduous vegetation to provide nutrients and food sources.
- Continue to implement restoration activities identified in the City of Seattle's Cedar River Habitat Conservation Plan (HCP).
- In Taylor/Downs Creek, key life stages would benefit from a reduction in stormwater flows that have increased bed scour and deposition of fine sediments.
- Restoration of seasonal low flows would support the pre-spawning holding life stage in Rock Creek.

Reach-Specific Hypotheses:

- Reduce channel confinement by removing bank armoring / hardening in Lower Rock reach 1.
- Increase pools by restoring large woody debris and riparian vegetation in Lower Rock reaches 1 and 2.
- Continue to implement restoration activities identified in the City of Seattle's Cedar River Habitat Conservation Plan (HCP).

These changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages in the Tier 2 sub-areas. The Technical Committee hypothesizes that improved conditions for these life stages in the Cedar Tributaries and the Upper Cedar will ultimately increase the spatial distribution, productivity, and diversity of the Cedar Chinook population.



Conservation Strategy for the North Lake Washington Chinook Population

VSP Status and Relative Risk for North Lake Washington Chinook

For the WRIA 8 North Lake Washington Chinook population, the assessment of the VSP population parameters can be summarized as follows:

Productivity: Reduced by habitat degradation. Currently, Chinook productivity is focused in the Bear Creek system (particularly Cottage Lake Creek and the mainstem of Bear Creek).

Diversity: Historically, it is likely that the variability in diversity within this population was low due to similar environmental regimes in the tributary sub-basins connected to the Sammamish River. It is likely that there were at least two different life-history trajectories for juvenile rearing: an early fry-migrant trajectory and a later smolt-migrant trajectory. The smolt-migrant life history is dominant in years of low flow and higher flows

Spatial Structure: The spatial distribution among the core and satellite areas has narrowed considerably compared to historic conditions. Approximately 90% of the population currently resides in Bear Creek; historically it is likely that the NLW Chinook population was distributed fairly evenly among Bear, North, Little Bear, and Kelsey Creeks.

Abundance: As shown in Chapter 4, the population abundance is at a very low level, driven primarily by reductions in habitat productivity and contraction of the spatial distribution. Hatchery strays are assumed to contribute to the current observed abundance.

At this time none of the four VSP attributes is sufficient to support viability of the population. Rehabilitation of all population attributes will be necessary to restore the population. The W8TC summarizes the relative risk posed to each of the four population attributes as follows:

- Productivity: High
- Diversity: Moderate to High depending on the level of hatchery straying (stray rates higher than 5-10% would result in high risk to the population)
- Spatial Structure: High
- Abundance: High (the W8TC assumes that increases in abundance result from rehabilitating the other three population attributes).

The W8TC suggests the following hypotheses based on this assessment of population attributes and relative risk:

- All population attributes require restoration if the NLW Chinook population is to be viable.
- Of the four population attributes, the greatest risk comes from reduction in habitat productivity and the severe contraction of the population distribution.
- Efforts to restore habitat productivity should include the Sammamish River and Lake Washington as well as the North Lake Washington tributaries.
- Hatchery influences pose a significant risk to the genetic diversity of the population.

Watershed Evaluation Framework for North Lake Washington

Following the assessment of Chinook salmon population attributes, the Technical Committee stratified sub-areas within each of the three WRIA 8 Chinook populations based on the degree of fish use and the level of watershed function. Using Chinook salmon demographic information to assess the relative abundance within sub-areas and the frequency that Chinook uses sub-areas, the NLW sub-areas can be organized as follows:

- Core areas of high Chinook abundance and frequent use – Upper Bear (Reaches 8-14), Lower Bear (Reaches 1-7), and Cottage (Reaches 1-5).
- Satellite areas of moderate Chinook abundance and moderately frequent use – Evans (Reaches 1-7), Upper Swamp, Lower Swamp, Little Bear (Reaches 1-12), and Kelsey Creeks
- Migratory areas – Sammamish River, Lakes Washington and Union, Ship Canal, Nearshore and Estuary.
- Episodic areas with infrequent Chinook use – McAleer Creek, Juanita Creek, Thornton Creek, May Creek, Coal Creek.

The relative watershed function of these sub-areas can then be assessed by rating factors that sustain function and factors that limit function:

- Factors sustaining watershed function: wetland area, forest cover, riparian cover, and gradient less than 2%.
- Factors limiting watershed function: Impervious surface, flow volume, road crossings, gradient >4%.

Following an assessment of watershed function factors listed above, the sub-areas that contribute to the North Lake Washington Chinook population can be organized as follows:

- High Function – Bear Creek Upper, Bear Creek Cottage.
- Moderate Function – Bear Creek Evans, Bear Creek Lower, Little Bear Creek, May Creek.
- Low Function – Swamp Creek Upper, Swamp Creek Lower, Kelsey Creek, McAleer Creek, Juanita Creek, Thornton Creek, Sammamish Valley Upper, Sammamish Valley Lower, Lakes Washington and Union, Ship Canal, Nearshore and Estuary.

By combining the fish use and watershed function ratings, the W8TC has stratified the sub-areas that contribute to the NLW Chinook population as follows:

- Tier 1 – Bear Creek Upper, Bear Creek Cottage, Bear Creek Lower
- Tier 2 – Bear Creek Evans, Upper North Creek, Lower North Creek, Little Bear Creek, Kelsey Creek².

² Kelsey Creek is included as a Tier 2 sub-area at this time due to the abundance and frequency of Chinook use. More research is needed to understand the genetic origin of the Chinook that use Kelsey Creek and why these fish continue to use the system despite the relatively low level of watershed function. Due to these outstanding questions, restoration and protection actions in this sub-area should be considered experimental.

- Tier 3 – McAleer Creek, Juanita Creek, Thornton Creek, Swamp Creek Upper, Swamp Creek Lower.

The W8TC suggests the following hypotheses based on the Watershed Evaluation Framework:

- Protection and restoration actions will be necessary in both tier 1 and tier 2 areas to rehabilitate NLW Chinook productivity, diversity, spatial distribution, and abundance.
- Watershed function can be improved by improving watershed conditions that limit function (i.e. total impervious area and road crossings) and enhancing factors that sustain function (i.e. total forest cover and riparian forest cover).
- Actions in areas of higher watershed function should focus on protecting habitat attributes and habitat-forming processes; actions in areas of moderate or low watershed function will require restoration of key habitat attributes and habitat-forming processes.

EDT Habitat Model Results and Recommendations for North Lake Washington

The results of the EDT diagnosis for each sub-area, and the protection and restoration hypotheses developed based on the application of VSP, the Watershed Evaluation Framework, and EDT are summarized in the following section. An appendix with a description of the EDT stream reaches is also included at the end of this document.

Habitat Protection and Restoration Hypotheses in the NLW Chinook Tier 1 Sub-Areas

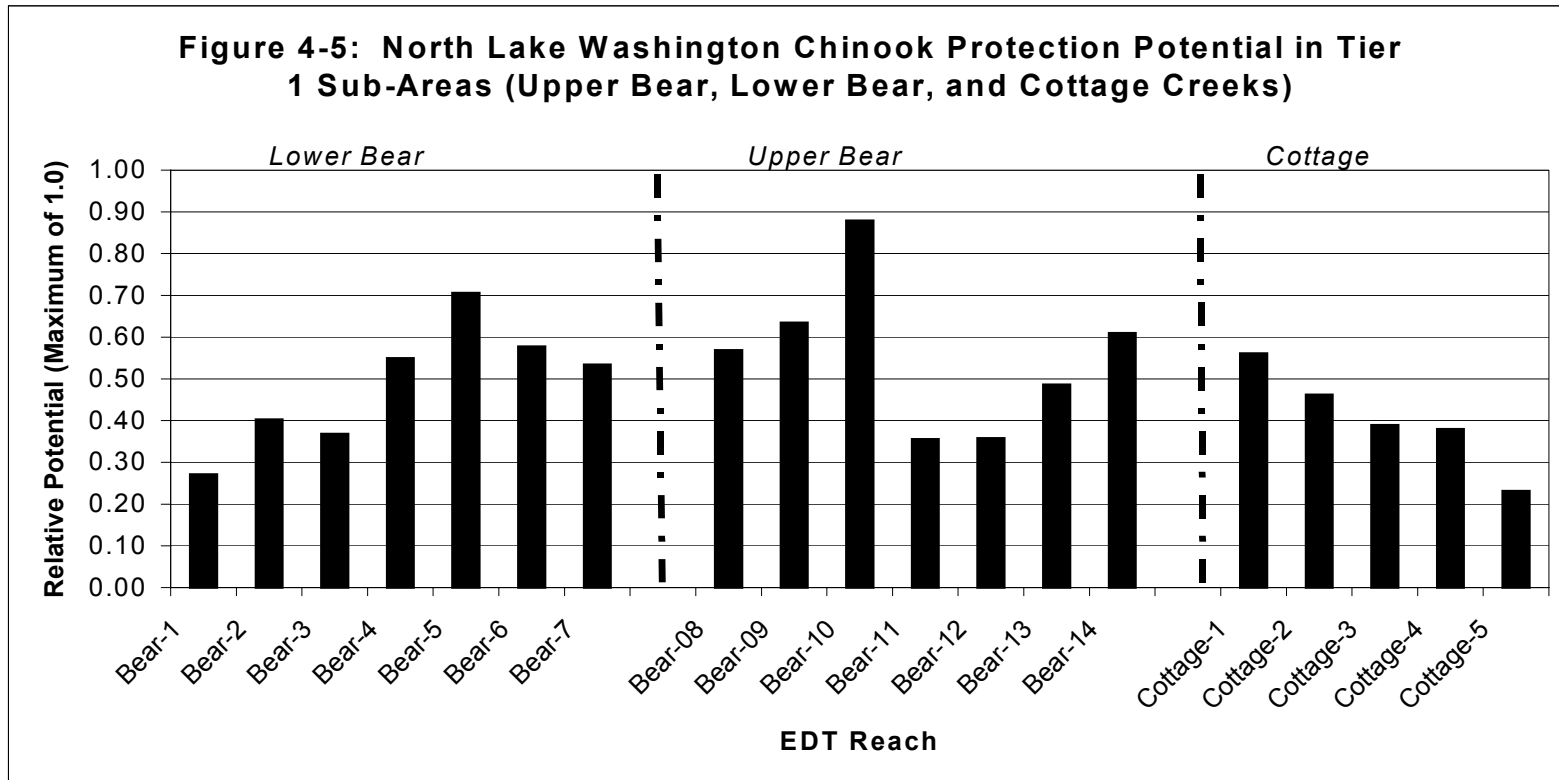
The Tier 1 sub-areas include Upper Bear (EDT Reaches 8-14), Lower Bear (EDT Reaches 1-7) and Cottage Creek (EDT Reaches 1-5). All three of these sub-areas are core areas for Chinook use. Cottage Creek and Upper Bear Creek have relatively high levels of watershed function resulting from a low impervious surface percentage, few road crossings, and a high level of forest cover and riparian forest. Lower Bear has a moderate level of watershed function, due primarily to increased impervious surface and storm flow volumes, along with reductions in forest cover and riparian cover.

Habitat Protection Hypotheses for the NLW Chinook Tier 1 Sub-Areas

Recommendations for these sub-areas focus on protection of the habitat processes and structures that make these areas a significant source of production for the North Lake Washington Chinook population. Using the EDT habitat model, the Technical Committee hypothesizes that in all three Tier 1 sub-areas the life stages most affected by existing high-quality habitat conditions are egg incubation, fry colonization and pre-spawning migrants. These critical life stages are sustained by protection of the following habitat attributes:

- Water quality (low levels of fine sediments, turbidity and metals, low water temperatures)
- Flows (sufficient flows during seasonal low flow periods)
- Habitat quantity (pool habitat areas to limit exposure to predators and high flow events)
- Habitat attributes that contribute to the creation of pool habitat area and provide cover (riparian function, LWD, channel connectivity).

By comparing the survival of Chinook life stages under existing conditions and fully degraded habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for protection. The protection potential of reaches in the Tier 1 sub-areas is shown in Figure 5-5. The protection potential identified by EDT results from habitat conditions in the stream reach as well as the habitat-forming processes that create and maintain those habitat conditions. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire sub-area (Table 5-7) as well as individual stream reaches (Table 5-8).



NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (ie hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each sub-area in the Conservation Strategy.

**Table 5-7: Basin-Wide Protection Recommendations for Tier 1 Sub-Areas
(Upper Bear, Lower Bear, Cottage Creek)**

- Headwater areas, wetlands, and sources of groundwater (e.g. seeps and springs) should be protected to maintain hydrologic integrity and a temperature regime that supports Chinook life stages.
- Riparian function (including overbank flows, vegetated streambanks, and groundwater interactions) should be protected throughout the basin to protect key Chinook life stages.
- Key Chinook life stages are maintained by protecting water quality to prevent adverse impacts from fine sediments, metals (both in sediments and in water), and high temperatures.
- The continued implementation of land use policies that protect critical areas (including groundwater sources), forested land cover, and minimize impervious surface will contribute to the protection of critical Chinook life stages.
- Adverse impacts from non-point source pollution (particularly road runoff) should be prevented through stormwater best management practices and the minimization of the number and width of roads in the basin.
- Provide adequate stream flow to allow upstream migration and spawning by establishing in-stream flow levels, enforcing water right compliance, and providing for hydrologic continuity.
- The impact of surface water and groundwater withdrawals on flow conditions for salmon life stages should be investigated and addressed.
- In order to maintain the existing high relative level of watershed function and hydrologic integrity (especially maintenance of sufficient baseflows), forest cover, wetland areas, and riparian forest should be maintained and increases in impervious surface and road crossings should be minimized.
- Sources of groundwater inflow to Cold Creek should be identified and protected to maintain cold temperatures and hydrologic integrity in Cottage Lake Creek and lower Bear Creek.
- Provide adequate stream flow to allow upstream migration and spawning by establishing in-stream flow levels, enforcing water right compliance, and providing for hydrologic continuity.
- Road crossings should be minimized to maintain floodplain connectivity.
- Spawning areas in Cottage Creek are the most significant source of productivity and abundance for the North Lake Washington Chinook population and should be protected.
- Spawning areas Bear Creek are a significant source of productivity and abundance for the North Lake Washington Chinook population and should be protected.
- Riparian function (including overbank flows, vegetated streambanks, and groundwater interactions) should be protected throughout the basin to protect key Chinook life stages.
- Key Chinook life stages are maintained by protecting water quality to prevent adverse impacts from fine sediments, metals (both in sediments and in water), and high temperatures.
- Opportunities to retrofit existing roadways (especially Avondale Road and SR-520) and commercial / industrial areas with stormwater treatment BMPs should be pursued.

**Table 5-8: Tier 1 Reach-Level Protection Recommendations
(Upper Bear, Lower Bear, Cottage Creek)
Reaches are listed in order of Relative Protection Priority**

<i>Tier 1 Sub-Area:</i>	<i>Critical Chinook Life Stages for Protection:</i>	<i>EDT Protection Potential: Protect pool habitats, LWD, riparian function, and channel connectivity, in the following reaches:</i>	<i>High-quality pool habitat should be protected in the following reaches:</i>	<i>LWD, Riparian Function, and Channel Connectivity should be protected in the following reaches:</i>
<i>Upper Bear</i>	Pre-Spawning Migrant; Fry Colonization	10, 9, 14, 8, 13, 12, 11	14, 12, 13, 9, 8, 10, 11	14, 13, 9, 10, 8, 11, 12
<i>Lower Bear</i>	Pre-Spawning Migrant; Fry Colonization; 0-Age Active Rearing	5, 6, 4, 7, 2, 3, 1	2, 4, 1, 7, 6, 3, 5	2, 7, 6, 5, 3, 4, 1
<i>Cottage</i>	Pre-Spawning Migrant; Fry Colonization	1, 2, 3, 4, 5	1, 5, 2, 3, 4	3, 2, 1, 4, 5

- Pool habitat and the habitat features that support the creation of pool habitat (LWD, riparian function, and channel connectivity) should be maintained in reaches with high protection potential in each sub-area in order to maintain key Chinook life stages. Table 5-8 lists the reaches in each sub-area beginning with reaches that have the relatively highest protection potential.
- Areas of relatively high-quality pool habitats providing cover and refuge for critical life stages should be protected and maintained. Table 5-8 lists the reaches in each sub-area beginning with reaches that have the relatively least degraded habitat conditions.
- Areas of relatively high-quality habitat forming features (LWD, riparian function, and channel connectivity) providing cover and refuge for critical life stages should be protected and maintained. Table 5-8 lists the reaches in each sub-area beginning with reaches that have the relatively least degraded habitat conditions.

Based on the three analytical tools described above, the W8TC hypothesizes that conservation actions based on the basin-wide and reach-specific protection recommendations will maintain habitat conditions that are currently favorable to critical Chinook life stages. The Technical Committee hypothesizes that actions based on these recommendations will maintain favorable conditions for these life stages in each of the three Tier 1 sub-areas (Upper Bear, Lower Bear, and Cottage Creeks) and will ultimately support the existing sources of productivity and life history diversity for the North Lake Washington Chinook population.

Habitat Enhancement Hypotheses for the NLW Chinook Tier 1 Sub-Areas

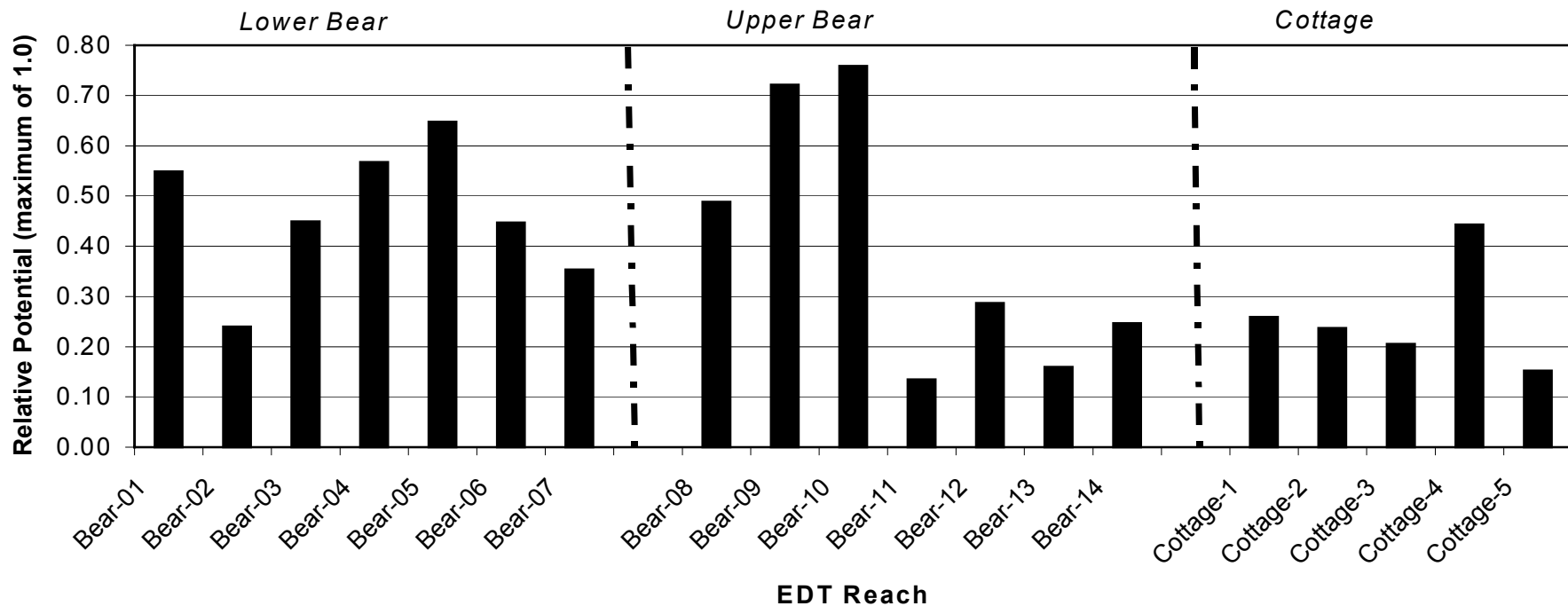
Although protection of existing high-quality habitat and habitat-forming processes is the primary objective in the Tier 1 sub-areas, restoration and enhancement of watershed function and in-stream habitat attributes would contribute to the rehabilitation of NLW Chinook population attributes, particularly the productivity of the population. Based on

the EDT habitat model, the Technical Committee hypothesizes that the life stages most affected by degraded habitat conditions in these reaches are egg incubation, juvenile active rearing (0-age), and fry colonization. These critical life stages are limited by degradation of the following habitat attributes:

- Sediment load (fine sediments)
- Channel stability (bed scour, riparian function, LWD)
- High flows
- Habitat diversity (channel confinement, riparian function, and LWD)
- Predation, interactions with non-native fish species, and elevated water temperatures.

By comparing the survival of Chinook life stages under existing conditions and fully restored habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for habitat restoration. The restoration potential of reaches in the Tier 1 sub-areas is shown in Figure 5-6. The relative restoration potential identified by EDT results from habitat conditions in the stream reach as well as up-stream habitat-forming processes that create and maintain those habitat conditions. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire sub-area as well as individual stream reaches. These recommendations are summarized in Table 5-9. The recommended changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the productivity, spatial distribution, and life history diversity of the North Lake Washington Chinook population.

Figure 4-6: North Lake Washington Chinook Relative Restoration Potential in Tier 1 Sub-Areas (Upper Bear, Lower Bear, and Cottage Creeks)



NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (ie hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each sub-area in the Conservation Strategy.

Table 5-9: Basin-Wide and Reach-Specific Restoration Recommendations for Tier 1 Sub-Areas (Upper Bear, Lower Bear, Cottage Creek)

Basin-Wide Recommendations:

- Egg incubation and fry colonization life stages would benefit from source control best management practices that reduce fine sediment inputs to the system. Additional studies are needed to improve our understanding of the sources of fine sediment in these sub-areas.
- Fry colonization life stage would benefit from riparian restoration to reduce peak water temperatures that favor non-native species and provide future sources of LWD.
- Egg incubation and fry colonization life stages would benefit from stormwater management practices that reduce sediment inputs from bed scouring high flows.
- Egg incubation and fry colonization life stages would benefit from riparian restoration to provide future sources of LWD that can improve channel stability and contribute to the creation of pool habitat areas with suitable cover.
- Fry colonization life stage would benefit from riparian restoration to reduce peak water temperatures that favor non-native species.
- Fry colonization life stage would benefit from a review of hatchery outplant policies to ensure that predation on wild Chinook is minimized.

Reach-Specific Recommendations:

- Fry colonization life stage would benefit from the addition of LWD to create pool habitat areas that reduce exposure to predators.
- Fry colonization and juvenile active-rearing life stage would benefit from reduction in channel confinement (particularly in Cottage Creek reaches 1 and 2 and the Lower Bear reaches) and the addition of LWD to create pool habitat areas that reduce exposure to predators and high flows.
- Egg incubation life stage would benefit from the addition of LWD to create pool habitat areas that trap fine sediments. This recommendation does not address the causes of the sediment problem, and is intended to complement the source control and flow control measures identified as part of the basin-wide hypotheses.

Restoration of Migratory and Rearing Areas for NLW Chinook

While enhancement of the Tier 1 sub-areas is important for rehabilitation of the NLW population, restoration of the Sammamish River and Lake Washington would have a significant beneficial impact on key Chinook life stages in Tier 1 and Tier 2 sub-areas. The EDT results provide a relative sense of the restoration potential in the Sammamish River and the NLW tributaries. The restoration potential of the Sammamish River is approximately equal to the restoration potential in Bear Creek, North Creek and Little Bear Creek, and is therefore a critical element of restoring Chinook in the Tier 1 and several of the Tier 2 sub-areas. In the Sammamish River, the key life stages are juvenile rearing and pre-spawning migrants. These critical life stages are limited by degradation of the following habitat attributes:

- Habitat quantity (pool habitat areas with adequate cover),
- Habitat diversity (LWD and riparian function)
- Water quality (temperatures that limit migration)

Restoration of these habitat attributes will benefit juvenile rearing and adult migration in the Sammamish River. Restoration of habitat conditions that support these life stages is

intended to increase the productivity, spatial distribution, and life history diversity of the North Lake Washington Chinook population. Restoration hypotheses for the Sammamish River are summarized in Table 5-10.

Although the restoration potential is not as high as the Sammamish River, Lake Washington restoration would also provide significant benefits to NLW Chinook. Based on the EDT habitat modeling effort, juvenile migrants would benefit from actions that reduce predation by cutthroats and other predators. Predation on juvenile Chinook appears to be driven primarily by conditions that limit cover for Chinook and increase exposure to predators, such as bank hardening, steep slopes, and a lack of LWD and shoreline vegetation. Restoration actions for Lake Washington are summarized in Table 5-10.

Table 5-10: Restoration Recommendations for NLW Migratory and Rearing Areas

Sammamish River:

- Restore floodplain connections and promote meandering as a way to increase connections with cool groundwater sources. Re-meandering and levee setbacks should focus on Sammamish River reaches 3-5.
- Restoration in Sammamish River reaches 1 and 2 should focus on the addition of backwaters pool areas, restoration of side channels, and the use of LWD as cover.
- Big LWD and jams may be necessary to restore functions and processes. Set back levees, need bigger scale projects than current projects.
- Restore riparian vegetation along the mainstem Sammamish and the Sammamish River tributaries. Restoration of tributaries is especially important as a means of cooling sources of inflow to the mainstem river.
- Raise the overall water level in the river channel. This can be achieved by inducing more groundwater flow, adding LWD, and increasing the 3-dimensional relief in the river channel.
- The impact of surface water and groundwater withdrawals on flow conditions for salmon life stages and the creation and maintenance of habitat structures should be investigated and addressed.
- Further investigations are needed into the potential for chemical contamination near the mouth of the Sammamish River at the site of the former cement plant near mouth.

Lake Washington:

- Reduce bank hardening by replacing bulkheads and rip-rap with sandy beaches with gentle slopes designed to maximize littoral areas with a depth of less than 1 meter.
 - Reconnect and enhance small creek mouths as juvenile rearing areas. Historically these small creeks had sandy deltas at the creek mouth and were associated with wetland complexes. Restoration efforts should start at the mouth of the Sammamish River, with other high potential reaches around the mouths of Kelsey and May Creeks, and Union Bay.
 - Juvenile Chinook in the NLW population are less shoreline-oriented than juveniles from the Cedar River. More information is needed about the trajectories of NLW juvenile Chinook in Lake Washington.
 - Shoreline processes of Lake Washington have been changed by the regulated maximum one foot rise and fall of the lake. Therefore, the removal of bank hardening structures may not be sufficient to create sandy beaches and augmentation of sediment supplies may be necessary.
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-
- The outmigration of juvenile Chinook would benefit from improved shoreline connectivity. The use of mesh dock surfaces and/or community docks would reduce the severity of predation on juvenile Chinook.
 - Restore coho runs in smaller tributaries as control mechanism to reduce cutthroat population.
 - Consider increases in fishing limits for cutthroat trout.

Ship Canal and Locks:

- High water temperatures impede juvenile Chinook outmigration during the summer in the Ship Canal. These high temperatures also lead to increased activity by predators (primarily bass). Options to reduce water temperatures in the Ship Canal should be evaluated.
- Additional investigations are needed to determine habitat characteristics that could provide Chinook with refuge from predators in the Ship Canal.
- Riparian vegetation should be restored to provide cover for juvenile migrants.

Estuary and Nearshore: TBD

Habitat Protection and Restoration Hypotheses in the NLW Chinook Tier 2 Sub-Areas

The Tier 2 Sub-Areas are currently under review by the WRIA 8 Technical Committee – Technical recommendations have not been developed at this time.

VSP Hypotheses: The Tier 2 sub-areas include Evans, North, Little Bear, and Kelsey Creeks. Historically, the spatial distribution of the NLW Chinook population was distributed fairly evenly among these areas and the Bear Creek system. Restoration of these sub-areas is necessary to increase the spatial distribution and productivity of the NLW Chinook population. These changes will reduce the risk of extinction from natural disturbances that results from having the population centered in one spawning area (Bear Creek), and will increase the viability of the population.

North Lake Washington Tier 2 Restoration Hypotheses

A. Satellite Area, High Function:

Evans Creek Reaches 1-7 (Bear Creek Confluence to 224th Street)

Summary of Watershed Conditions

Moderate impacts from all factors except road crossings (low); High mitigation from wetland %, and gradient, moderate mitigation from forest cover and riparian forest cover.

EDT Chinook Life Stage and Habitat Attribute Hypotheses

The restoration potential of reaches in this sub-area is shown in Figure __ below.

The life stages most affected by degraded habitat conditions in these reaches are egg incubation, juvenile active rearing (0-age), and fry colonization. These critical life stages are limited by degradation of the following habitat attributes:

Figure 4-7: North Lake Washington Chinook Restoration Potential in Tier 2 Sub-Areas (Evans, Upper North, Lower North, Little Bear, and Kelsey)

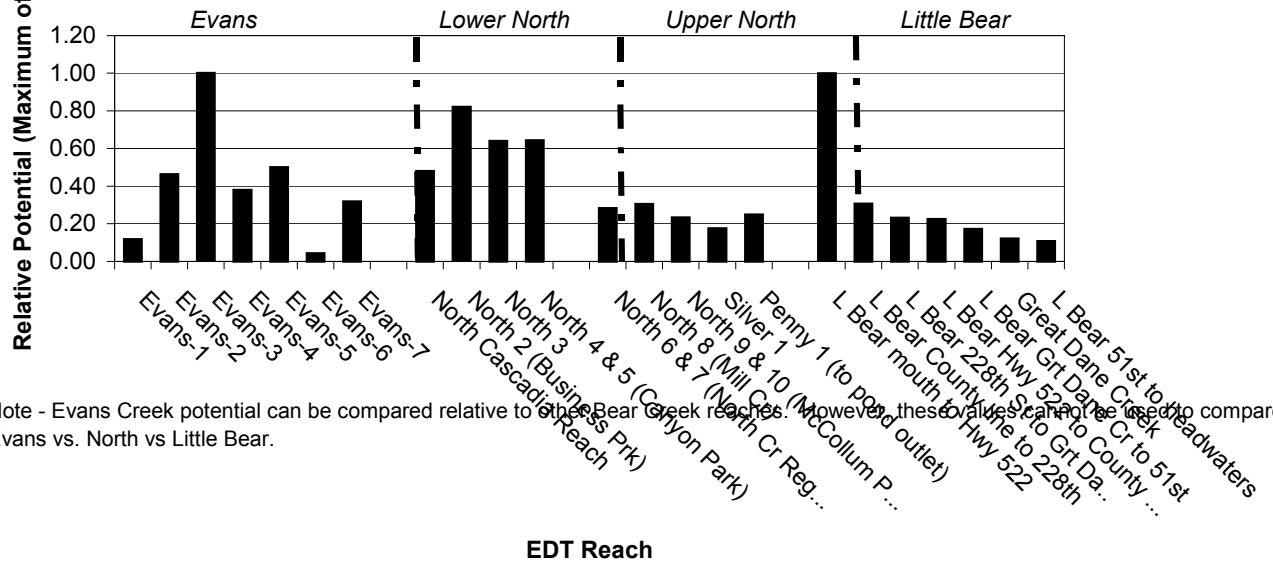
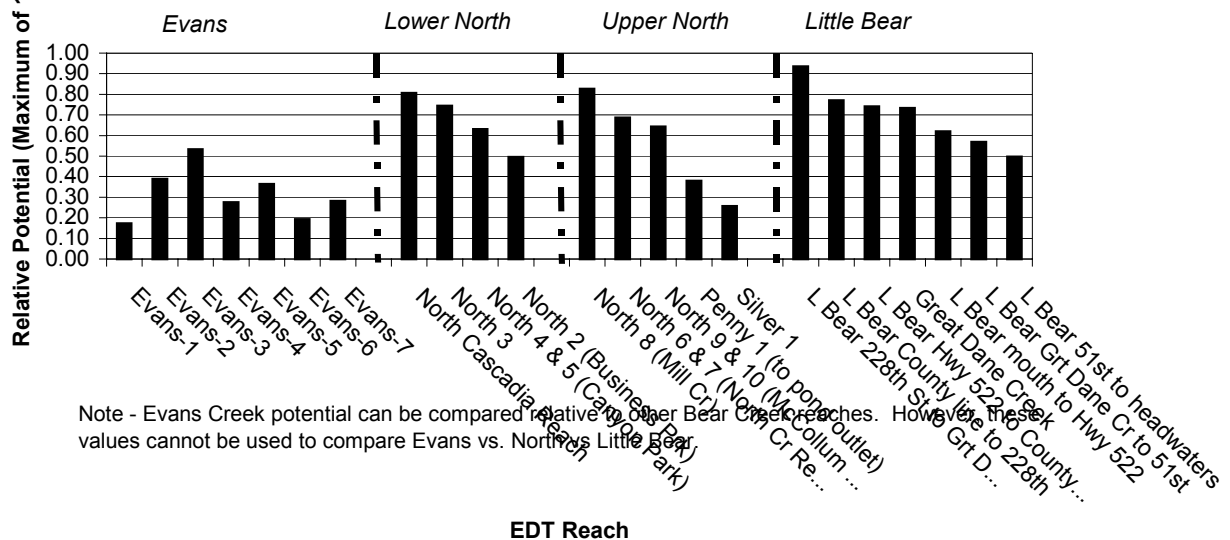


Figure 4-8: North Lake Washington Chinook Relative Protection Potential in Tier 2 Sub-Areas (Upper North, Lower North, Little Bear, and Kelsey)



Conservation Strategy for Issaquah Creek Chinook

NOTE: The WRIA 8 Technical Committee has not completed its discussion of potential interactions between the NLW and Issaquah Creek chinook populations. To date, the W8TC has been concerned about the potential for environmental conditions in the Sammamish River to limit adult salmonid migration through this corridor, thereby increasing the potential for straying of Issaquah Creek fish into the NLW tributaries, mixing the two populations. Until this issue is clarified (scheduled for further discussion on 2/4/04), both protection and restoration recommendations are presented here.

VSP Status and Relative Risk for Issaquah Creek Chinook

For the WRIA 8 Issaquah Chinook population, the assessment of the VSP population parameters can be summarized as follows:

Productivity: Habitat productivity has been reduced primarily by the loss of floodplain connectivity and off-channel habitat caused by extensive bank armoring. Armoring has isolated potentially productive floodplain habitats, concentrated high flow events in the main channel, and degraded riparian areas. Productivity of naturally reproducing Chinook may be affected by competition from hatchery strays

Diversity: Based on the original drainage pattern for the Cedar/Lake Washington Basin, it is unclear if Issaquah Creek historically supported an independent population of Chinook. Hatchery stocks, mostly from Green River brood stock, have heavily influenced the genetic composition of Chinook in Issaquah Creek. Hatchery fish from south Puget Sound and the north Kitsap Peninsula have also been observed in Issaquah Creek.

Spatial Structure: Due to the small size and condition of tributaries to Issaquah Creek, naturally reproducing chinook use is now and historically was concentrated in the mainstem of Issaquah Creek along with Carey and Holder Creeks.

Abundance: Hatchery strays and naturally-spawning hatchery fish are assumed to constitute the majority of the observed abundance. WDFW's evaluation of this stock as 'Healthy' is based on the inclusion of hatchery fish.

At this time none of the four VSP attributes is sufficient to support viability of the population. Rehabilitation of all four population attributes will be necessary to restore the population. The relative risk posed to each of the four population attributes is:

- Productivity: High
- Diversity: High
- Spatial Structure: Moderate
- Abundance: High

The W8TC suggests the following hypotheses based on this assessment of population attributes and relative risk:

- All population attributes require restoration if the Issaquah Chinook population is to be viable.
- Of the four population attributes, the greatest risk comes from reduction in habitat productivity and a reduction in genetic diversity due to hatchery influences.

Watershed Evaluation Framework for Issaquah Creek

Following the assessment of Chinook salmon population attributes, the Technical Committee stratified sub-areas within each of the three WRIA 8 Chinook populations based on the degree of fish use and the relative level of watershed function. Using Chinook salmon demographic information to assess the relative abundance within sub-areas and the frequency that sub-areas are used by Chinook, the Issaquah sub-areas can be organized as follows (please note that for the Issaquah population this demographic information is heavily influenced by hatchery counts):

- Core areas of high Chinook abundance and frequent use: Upper Issaquah (Carey and Holder), Middle Issaquah (reaches 11-12), Lower Issaquah (reaches 1-10), Fifteenmile Creek, East Fork Issaquah, North Fork Issaquah
- Satellite areas of moderate Chinook abundance and moderately frequent use – none.
- Migratory areas – Lakes Sammamish, Washington, and Union, Sammamish River, Ship Canal, Nearshore and Estuary.
- Episodic areas of low Chinook abundance and infrequent use – McDonald Creek, Tibbetts Creek.

The relative watershed function of these sub-areas can then be assessed by rating factors that sustain function and factors that limit function:

- Factors sustaining watershed function – Wetland area, forest cover, riparian cover, gradient less than 2%.
- Factors limiting watershed function – Impervious surface, flow volume, road crossings, gradient greater than 4%.

Following an assessment of watershed function factors listed above, the sub-areas that contribute to the Issaquah Chinook population can be organized as follows:

- High Function – Carey/Holder Creeks (Upper Issaquah), Middle Issaquah, Fifteenmile, North Fork
- Moderate Function – Lower Issaquah, East Fork, McDonald, Tibbetts
- Low Function – Migratory areas (Lake Sammamish, Sammamish River, Lake Washington, Lake Union, Nearshore and Estuary).

By combining the fish use and watershed function ratings, the W8TC has stratified the sub-areas that contribute to the Issaquah population as follows:

- Tier 1 – Carey/Holder Creeks (Upper Issaquah), Middle Issaquah, Lower Issaquah, Fifteenmile Creek, North Fork, East Fork
- Tier 2 – None
- Tier 3 – McDonald Creek, Tibbetts Creek.

The W8TC suggests the following hypotheses based on the Watershed Evaluation Framework:

- Protection and restoration/enhancement actions will be necessary in Tier 1 areas to rehabilitate Issaquah Chinook productivity, diversity, spatial distribution, and abundance.

- Watershed function can be improved by improving watershed conditions that limit function (especially total impervious surface and the number of road crossings) and protecting factors that sustain function (especially forest cover and riparian forest).
- Actions in areas of high watershed function (Carey/Holder and Fifteenmile Creeks, Middle Issaquah, and North Fork Issaquah) should focus on protecting habitat attributes and habitat-forming processes to prevent any reduction in relative watershed function; actions in areas of moderate watershed function should focus on enhancement of habitat-forming processes and key habitat attributes.

EDT Habitat Model Results and Recommendations for Issaquah Creek

The results of the EDT diagnosis for each sub-area, and the protection and restoration hypotheses developed based on the application of VSP, the Watershed Evaluation Framework, and EDT are summarized in the following section. An appendix with a description of the EDT stream reaches is also included at the end of this document.

Habitat Protection and Restoration Hypotheses for the Issaquah Chinook Tier 1 Sub-Areas

The Tier 1 sub-areas include Carey/Holder and Fifteenmile Creeks, Lower (reaches 1-10) and Middle (reaches 11-12) Issaquah Creek, and the North and East Forks of Issaquah Creek. Each of these sub-areas is considered a core area, but there are differences in the relative level of watershed function. The moderate function sub-areas (Lower Issaquah and East Fork) have relatively high impacts from increases in impervious surface and relatively moderate impacts from increased stormflow volumes. For both the moderate and high function sub-areas, forest cover and riparian forest cover are relatively intact and should be maintained to support watershed function.

Habitat Protection Hypotheses for the Issaquah Chinook Tier 1 Sub-Areas

Recommendations for the Tier 1 sub-areas focus on protection of the habitat processes and structures that make these areas a significant source of production for the Issaquah population. Using the EDT habitat model, the Technical Committee hypothesizes that the life stages most affected by existing high-quality habitat conditions in the Tier 1 sub-areas are egg incubation, fry colonization and pre-spawning migrants. These critical life stages are sustained by protection of the following habitat attributes:

- Water quality (low levels of fine sediments, turbidity and metals, low water temperatures)
- Flows (sufficient flows during seasonal low flow periods)
- Habitat quantity (pool habitat areas to limit exposure to predators and high flow events)
- Habitat attributes that contribute to the creation of pool habitat area and provide cover (riparian function, LWD, channel connectivity).

By comparing the survival of Chinook life stages under existing conditions and fully degraded habitat conditions, the EDT habitat model ‘diagnoses’ the potential of stream reaches for protection. The protection potential of reaches in the Tier 1 sub-areas is shown in Figure 5-9. The protection potential identified by EDT results from habitat conditions in the stream reach as well as the habitat-forming processes that create and maintain those habitat conditions. For this reason the Technical Committee has used

the watershed evaluation and EDT to prepare technical recommendations for the entire sub-area (Table __) as well as individual stream reaches (Table __).

**Table 5-_: Basin-Wide and Reach-Specific Protection Recommendations
for Issaquah Creek Tier 1 Sub-Areas**

Basin-Wide Protection Hypotheses:

- Headwater areas, wetlands, and sources of groundwater (e.g. seeps and springs) should be protected to maintain hydrologic integrity and a temperature regime that supports Chinook life stages.
 - Key Chinook life stages are maintained by protecting water quality to prevent adverse impacts from fine sediments, metals (both in sediments and in water), and high temperatures.
 - The continued implementation of land use policies that protect critical areas (including groundwater sources), forested land cover, and minimize impervious surface will contribute to the protection of critical chinook life stages.
 - Adverse impacts from road runoff should be prevented through stormwater best management practices and the minimization of the number and width of roads in the basin. Opportunities to retrofit existing roadways with stormwater treatment BMPs should be pursued.
 - Provide adequate stream flow to allow upstream migration and spawning by establishing in-stream flow levels, enforcing water right compliance, and providing for hydrologic continuity. Flows in the east and north forks should be maintained and improved to avoid stranding of chinook.
 - In order to maintain the existing high relative level of watershed function and hydrologic integrity (especially maintenance of sufficient baseflows), forest cover, wetland areas, and riparian forest should be maintained and increases in impervious surface and road crossings should be minimized.
 - Road crossings should be minimized to maintain floodplain connectivity.
 - Riparian function (including overbank flows, vegetated streambanks, and groundwater interactions) should be protected throughout the basin to protect key Chinook life stages.
 - Sources of groundwater should be identified and protected to maintain cold temperatures and hydrologic integrity. Carey and Holder creeks are believed to be important cold water sources and should be protected.
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Table 5-10: Issaquah Creek Tier 1 Reach-Level Protection Recommendations
Reaches are listed in order of Relative Protection Priority

<i>Tier 1 Sub-Area:</i>	<i>Critical Chinook Life Stages for Protection:</i>	<i>EDT Protection Potential: Protect pool habitats, LWD, riparian function, and channel connectivity, in the following reaches:</i>	<i>High-quality pool habitat should be protected in the following reaches:</i>	<i>LWD, Riparian Function, and Channel Connectivity should be protected in the following reaches:</i>
<i>Carey/Holder</i>	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	Carey 1; Carey 2-3; Holder 1; Carey 4; Holder 2-3	Carey 1, 2, and 5; Carey 3; Holder 1; Holder 2-3	Holder 2; Carey 4; Holder 3; Carey 1-3 and Holder 1
<i>Middle Issaquah</i>	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	11; 12	12; 11	11; 12
<i>Lower Issaquah</i>	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	2; 1; 6; 7; 8; 9; 10; 3-5	7; 3 and 5; 2; 8-10; 1; 4 and 6	7 and 9; 1-2; 6, 8, and 10; 3-5
<i>Fifteenmile</i>	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	2; 1	2; 1	2; 1
<i>North Fork</i>	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	1-2; 3	2; 3; 1	1; 3; 2
<i>East Fork</i>	Pre-Spawning Migrant; Fry Colonization; Egg Incubation	3; 1-2	2; 3; 1	3; 2 and 1

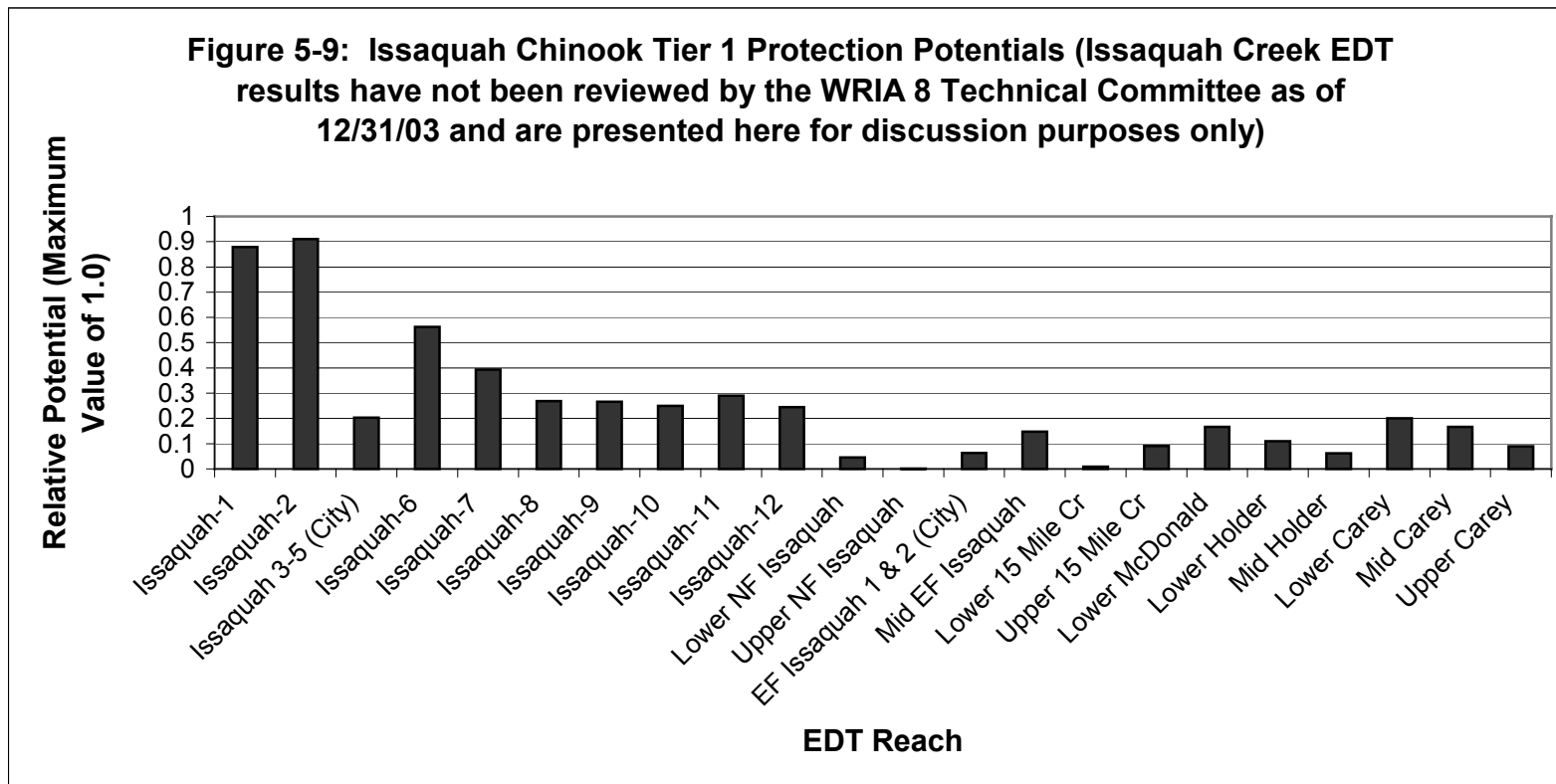
Reach-Level Protection Hypotheses (based on Table 5-10):

- Key chinook life stages are maintained by protecting habitat quantity (pool habitats), habitat diversity (riparian function, LWD, and channel connectivity), and spawning areas. The protection potential identified by EDT results from the quality of the habitat attributes as well as the quality of habitat attributes up-stream.
- In each Tier 1 sub-area, pool habitat and the habitat features that support the creation of pool habitat (LWD, riparian function, and channel connectivity) should be maintained in reaches with high protection potential in order to maintain key Chinook life stages, as identified by EDT.
- Pool habitats that provide cover and refuge for critical life stages should be protected and maintained, starting with the protection of existing off-channel and pool areas in Carey Creek (reaches 1-4), Issaquah reaches 7, 12, and 3.

- Habitat forming features (LWD, riparian function, and channel connectivity) that provide cover and refuge for critical life stages should be protected and maintained, starting with Carey Creek (especially reach 4), Holder Creek (especially reach 2), EF Issaquah reach 2, and Fifteenmile Creek reach 2.
- LWD in reaches 1 and 2 should be maintained – restoration efforts in the state park reaches should proceed cautiously to avoid adverse impacts to existing habitat.

Protection of these habitat attributes at the reach and basin scale is intended to maintain habitat conditions that are currently favorable to critical chinook life stages. The Technical Committee hypothesizes that maintaining favorable conditions for these life stages will ultimately support the existing sources of productivity and life history diversity for the Issaquah Chinook population.

NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (ie hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each sub-area in the Conservation Strategy.



Issaquah Tier 1 Restoration Hypotheses

The life stages most affected by degraded habitat conditions in these reaches are egg incubation, pre-spawning holding and fry colonization. These critical life stages are limited by degradation of the following habitat attributes:

- Habitat quantity (pool habitat areas) and quality (riparian function, LWD, and channel confinement)
- Channel stability (bed scour, riparian function, LWD)
- Sediment load (fine sediments)
- High and low flows.

By comparing the survival of Chinook life stages under existing conditions and fully restored habitat conditions, the EDT habitat model 'diagnoses' the potential of stream reaches for habitat restoration. The restoration potential of reaches in the Tier 1 sub-areas is shown in Figure 5-10. The relative restoration potential identified by EDT results from habitat conditions in the stream reach as well as up-stream habitat-forming processes that create and maintain those habitat conditions. For this reason the Technical Committee has used the watershed evaluation and EDT to prepare technical recommendations for the entire sub-area as well as individual stream reaches. These recommendations are summarized in Table 5-3. The recommended changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical Chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the productivity, spatial distribution, and life history diversity of the North Lake Washington Chinook population.

Table 5-_: Basin-Wide and Reach-Specific Restoration Recommendations for Issaquah Creek Tier 1 Sub-Areas

Basin-Wide Restoration Hypotheses:

- Restore riparian vegetation to provide sources of LWD that can contribute to the creation of pool habitat.
- Egg incubation and fry colonization life stages would benefit from source control best management practices that reduce fine sediment inputs to the system.
- Egg incubation and fry colonization life stages would benefit from stormwater management practices that reduce sediment inputs from bed scouring high flows.
- Egg incubation and fry colonization life stages would benefit from riparian restoration to provide future sources of LWD that can improve channel stability and contribute to the creation of pool habitat areas with suitable cover.
- Fry colonization life stage would benefit from riparian restoration to reduce peak water temperatures that favor non-native species.
- Restoration of seasonal low flows would support the pre-spawning holding life stage in Issaquah Creek and the North and East Forks of Issaquah Creek.
- Fry colonization life stage would benefit from a review of hatchery outplant policies to ensure that predation on wild Chinook is minimized.

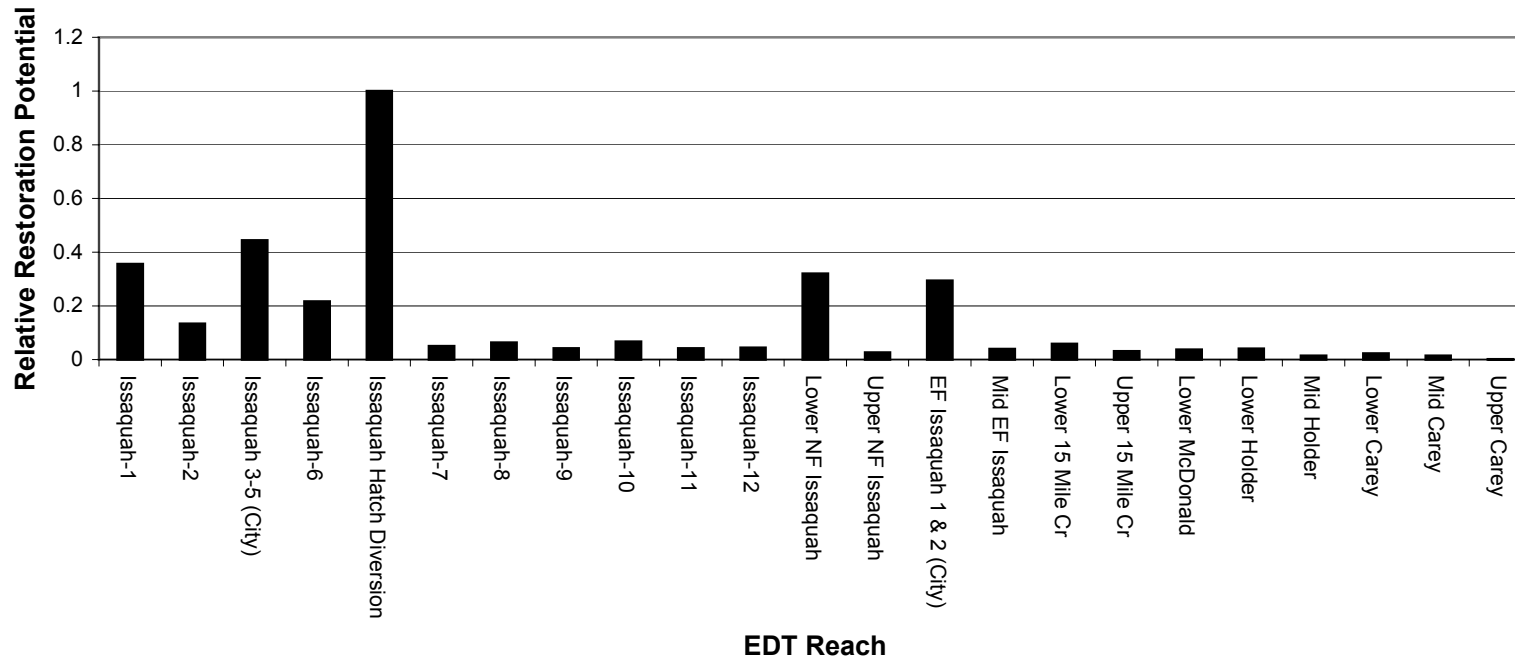
Reach-Level Restoration Hypothesis:

- Channel confinement has reduced floodplain connectivity and reduced the amount of pools and small cobbles. Reach-level restoration actions should focus on setback or removal of dikes and levees, the addition of LWD to create pools,
-

and planting riparian vegetation.

- Fry colonization life stage would benefit from the addition of LWD to create pool habitat areas that reduce exposure to predators.
 - Egg incubation life stage would benefit from the addition of LWD to create pool habitat areas that trap fine sediments. This recommendation does not address the causes of the sediment problem, and is intended to complement the source control and flow control measures identified as part of the basin-wide hypotheses.
 - Restoration in the State Park reaches (1 and 2) should proceed cautiously to avoid adverse impacts to existing habitat.
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These changes to habitat attributes at the reach and basin scale are intended to create habitat conditions more favorable to critical chinook life stages. The Technical Committee hypothesizes that improved conditions for these life stages will ultimately increase the productivity, spatial distribution, and life history diversity of the Issaquah Chinook population.

Figure 5-10: Issaquah Chinook Relative Restoration Potential

NOTE: The EDT habitat model determines the relative potential of a reach for salmon performance (a combination of productivity, abundance, and life history diversity) based on habitat conditions in the stream reach and the exposure of Chinook life stages to those habitat conditions. Similar habitat conditions may therefore result in different potentials due to differences in Chinook exposure. In addition, the salmon performance potential that exists in a reach may be due to upstream conditions (ie hydrologic conditions or sources of sediments and LWD) as well as conditions in the reach. For more information about habitat conditions, key life stages, and technical recommendations, please see the description of each sub-area in the Conservation Strategy.

Summary of the WRIA 8 Conservation Strategy

The risk of extinction posed to all three of the WRIA 8 Chinook populations is extreme and must be reduced through actions that create habitat conditions that support viability of each independent population. There is some uncertainty that the NLW and Issaquah populations are independent of one another. The W8TC therefore hypothesizes that a higher priority should be placed on risk reduction for the Cedar Chinook population.

Cedar River Chinook

The greatest source of risk comes from reduction in habitat productivity and the potential loss of the in-stream juvenile rearing life history strategy. Rehabilitation of the Cedar Chinook population requires conservation actions to protect and restore habitat in the Tier 1, Tier 2, and migratory sub-areas. The main source of productivity for this population is in the Tier 1 sub-areas along the mainstem of the Cedar River. Restoration of these sub-areas is important to increase productivity and create habitat conditions that support the in-stream juvenile rearing life history strategy. Hypotheses about conservation actions are summarized in Table ___ and ___, and are focused on the protection of water quality and high-quality in-stream habitats used for spawning and juvenile rearing, such as intact pool habitats, riparian buffers, and LWD. Restoration hypotheses are focused on increasing the availability of pool habitats and off-channel areas for juvenile Chinook by re-connecting floodplain areas, adding LWD, and re-planting riparian vegetation. In addition to restoration actions in the mainstem Cedar, juvenile Chinook would benefit from shoreline restoration actions designed to reduce predation by cutthroat trout and other predators in the south end of Lake Washington and in the Ship Canal. Shoreline restoration activities should focus on removal of bulkheads and rip-rap to create sandy, shallow habitat areas. These restoration actions should be focused on areas adjacent to the mouth of the Cedar River, along the south end of Mercer Island, at the mouths of small creeks, and in Union Bay.

North Lake Washington Chinook

The low abundance of the NLW Chinook population results from reduced habitat productivity and severe reduction in the spatial distribution of the population from several streams systems with approximately equal contribution to the population (Bear, Little Bear, North, and Kelsey Creeks) to one stream system (Bear Creek) that is the core of the population. In addition, hatchery influences pose a significant risk to the genetic diversity of the population. In order to rehabilitate this population and reduce the risks of extinction, conservation actions should be targeted at protecting the existing source of productivity in the Bear Creek system, restoring the habitat capacity of the Tier 2 NLW tributary systems, and restoring the channel meanders and pool habitats that support juvenile rearing and adult migration in the Sammamish River corridor.

Issaquah Creek Chinook

(NOTE: The W8TC will be re-evaluating some of the fundamental conclusions about Issaquah / NLW populations interactions at their 2/4/04 meeting). Conservation actions for the Issaquah population should focus on protection of existing high-quality habitat in the Issaquah system and restoration of habitat conditions in the Sammamish River. Current habitat conditions in the Sammamish River may increase straying of the Issaquah population into the NLW tributaries resulting in a mixing of the two populations. In order to reduce the risk of mixing these two independent populations, attempts to increase habitat productivity in the Issaquah system should wait until environmental conditions in the Sammamish River are more favorable to Chinook.